Tactical Decision Aids Using Modeling and Simulation; Participation in AOSN II Exercise

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LONG-TERM GOALS

The goals are to develop Tactical Decision Aids (TDAs) for using small autonomous underwater vehicles in very shallow water (VSW) environments. TDAs enable operators to view data gathered by these vehicles and make informed decisions as to the conduct of mine counter measures operations. This project is examining the use of command and control vehicles to aid in reducing latency of decision making and improvements to overall MCM reliability using multiple vehicles.

OBJECTIVES

The current tactical decision aids system used by the US Navy for mine countermeasures is a system named MEDAL (Mine warfare Environmental Decision Aids Library). MEDAL is a software package running inside the GCCS-M global command and control system used by Navy ships. It is used to evaluate asset positions, minelike contacts, snippet images of contacts, snippet images of those contacts later identified as mines, and bathymetry maps. Other data such as bottom typing may be displayed if available. The objectives include the timely gathering of AUV data, converting, archiving, and translating it into the form familiar in MEDAL to Naval operational personnel. Specific objectives are to demonstrate use of both underwater and radio communications links using server vehicles to speed the information gathering and display processes in multi-vehicle layered MCM systems.

APPROACH

As reported previously, an Automated Data Server (ADS) has been developed and demonstrated during ONR exercises for gathering MCM data and display in MEDAL. This year, the use of the NPS ARIES vehicle has demonstrated data gathering from a fixed data gathering node mounted on the ocean bottom, and acoustic tactical control of AUVs has been studied with commercially available modems for both command changes, mission re-directs, vehicle state queries, and data file transfers. Each of these elements is critical to the data gathering capabilities of a multi-vehicle system. Operating in very shallow water has yielded realistic range and data rate limitations inherent to this type of system. These limitations have led to a study of vehicle to vehicle rendezvous to reduce transmission range thereby allowing increased data rates for file transfer. Experiments have begun with data transfer between a fixed bottom mounted node equipped with a Benthos telesonar modem and a vehicle-borne modem. This experimental series was demonstrated during the ONR sponsored Autonomous Oceanographic Sampling Networks (AOSN) II exercise. Also, the results of command

and control experiments were evaluated using a ship-mounted modem controlled through a radio link in a Command Post (CP) and the underwater vehicle (Figure 1).

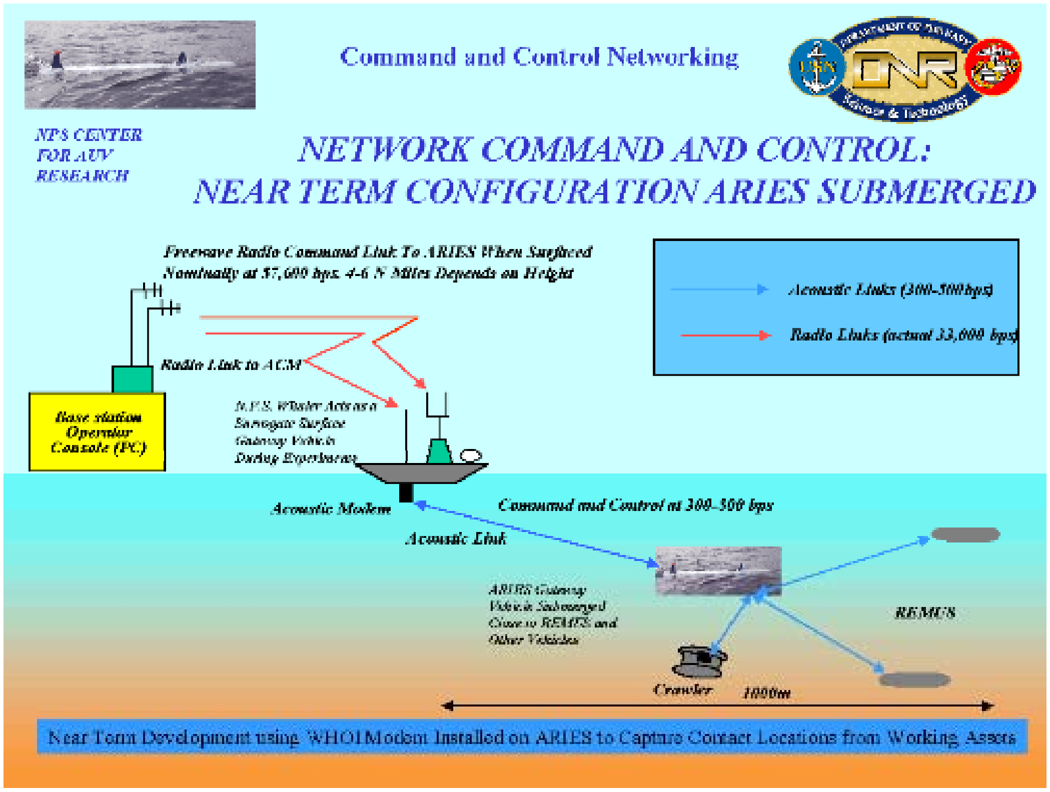

Figure 1. Experimental Command and Control Network Planned for Near Term.

WORK COMPLETED

Work completed on Acoustic Tactical Control has been described in the Doctoral dissertation of CDR W. J. Marr [1], and work on vehicle to vehicle rendezvous is underway in the doctoral dissertation of CAPT. J. Nicholson [2]. Additionally, during the month of August 2003, work has been completed during the AOSN II exercise in Monterey Bay with the Data Bus experiment and long transect up and down cast data gathering runs using the NPS REMUS vehicle. For the duration of the exercise, the Cypress Sea was used to deploy vehicles. The Cypress Sea is a 40 ft. Dive Support boat configured with a 700 lb. Hoist designed to launch and recover the ARIES vehicle. The REMUS vehicle was launched manually, Figure 2, and recovered using a rake tool. Figure 3 below shows the NPS Team with both ARIES and REMUS on deck.

The ARIES vehicle is normally navigated using inertial gyros, compass, acoustic ground locked Doppler speed sensing with altitude and depth sensing and GPS corrections when surfaced. It was configured with a Benthos Telesonar modem allowing for 150 to 2400 bits per second, FSK encoded messaging and up to 15,240 bits per second PSK encoded messaging. While the high rate messaging is designed to be used with file transfers, it was found that in practice, with the water depths used (72m.), only the FSK modes were feasible, and specifically, 1200 bits per second with ½ convolutional coding was used successfully.

Figure 2. Launching REMUS

Figure 3. ARIES and REMUS on Deck, Cypress Sea

The REMUS vehicle carried the standard Marine Sonics side scan sonar, the Optical Backscatter probe, and the Sonde 600XL CTD sensor. It also has an upward and downward looking ADCP for ground speed when in bottom lock mode and water speed sensing. Navigation is performed using acoustic LBL transponders.

Operational Area

The experiments were conducted in Monterey Bay in support of the AOSN II exercise. The southern half of the Bay was used for both the acoustic network data bus experiment, and the long transect casts with REMUS. Figure 4 illustrates the area used.

RESULTS

Data Bus Experiment Results

In the data bus experiment, current profiles were measured with an upward looking ADCP and recorded every minute and logged in the log file of a bottom mounted modem attached to the ADCP. Logging every 4 minute average profiles was determined sufficient. Servicing the modem every 24 hours produced a log file size of approximately 127K Bytes. These were downloaded using ARIES and send back to the CP with the radio link. The profiles were analyzed and posted generally within a few hours of the ARIES deployment. Overall 4.7 Mbytes of data were transferred through the water at 1200 bits per second.

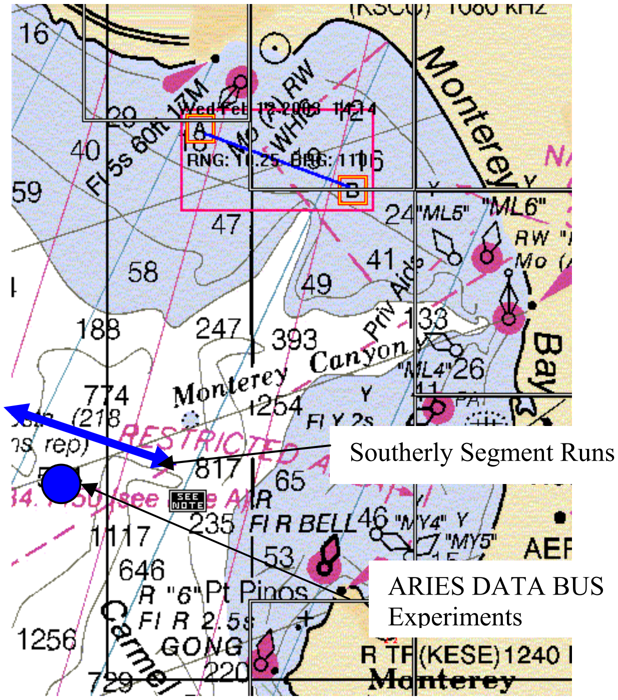

Figure 4. Monterey Bay Operational Area for AOSN II

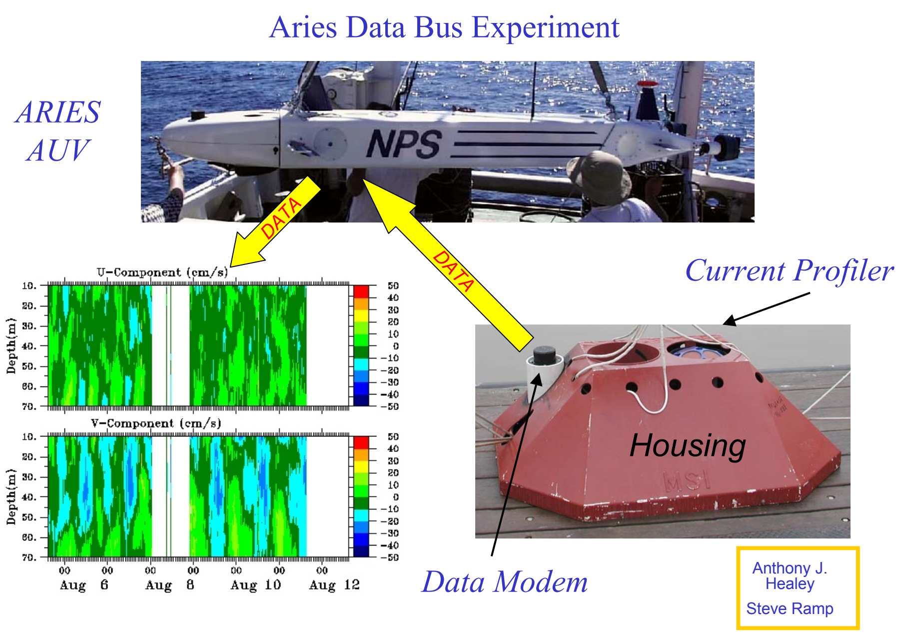

Figure 5. Data Bus Experiment for Current Profile Recording and Transmission

REMUS Long Transects

In the REMUS long transect runs, temperature and conductivity data was recorded during up and down casts over 18 km runs both outbound and inbound. The results were used by the AOSN modeling team to evaluate prediction models for Monterey Bay oceanography. The results indicate several pockets of high salinity water embedded in lower salinity zones that indicate unstable pockets. It is not clear yet whether this is the result of sensor placement in REMUS or physically real. Under investigation is the issue of proper water flushing in the REMUS nose. The temperature data was qualified as useable for comparison with model predicted data. Figure 6 illustrates the data as processed. Runs were conducted throughout the month of August.

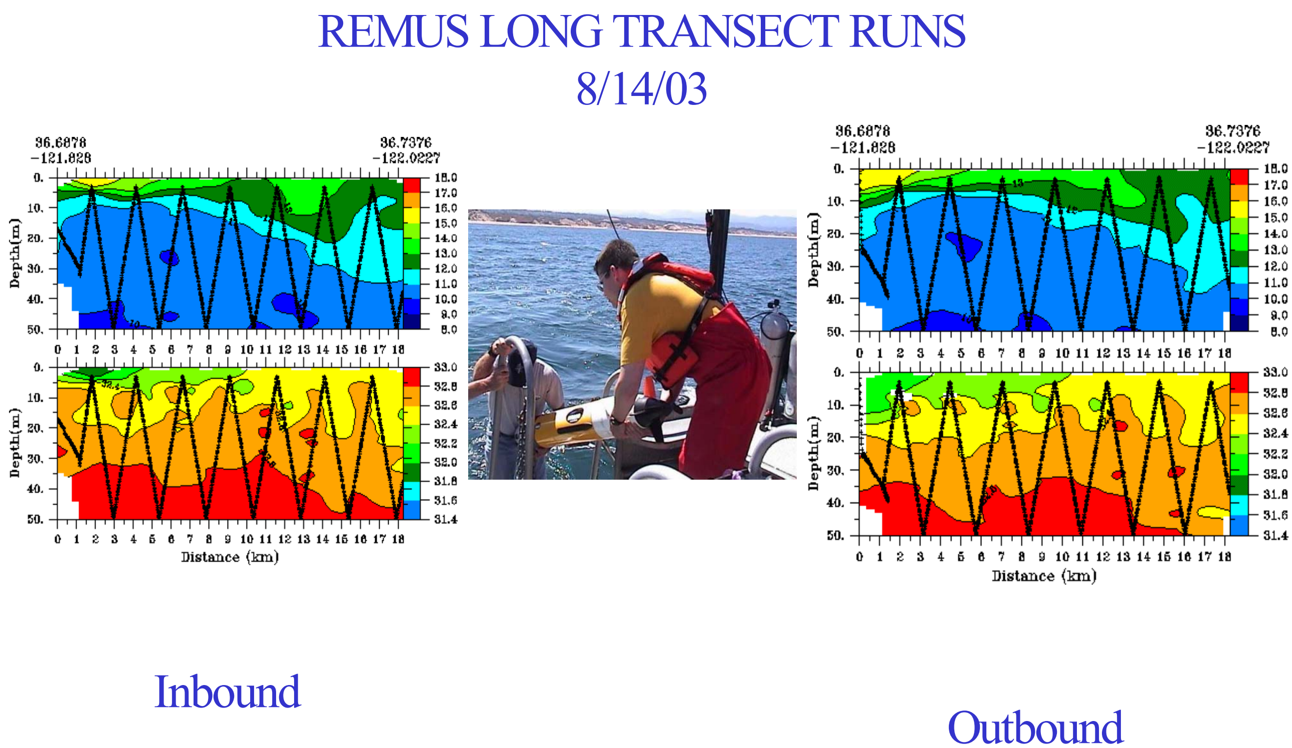

Figure 6. REMUS Long Transect Data Gathering, Temperature and Salinity Profiles.

IMPACT/APPLICATIONS

Results are being used in the AOSN II Project. Extensions lead to enhancements in MCM operations.

TRANSITIONS

Possible transitions to the SHARV improvement program.

RELATED PROJECTS

Autonomous Oceanographic Sampling Network s (AOSN II) and Blazed Array Forward Look Sonar.

REFERENCES

[1] Marr, W. J., "*Acoustic Based Tactical Control Of Underwater Vehicles*", Ph.D., Dissertation, Naval Postgraduate School, Monterey, California, June 2003.

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PUBLICATIONS

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2. Churan, C, "*Obstacle Avoidance Control for REMUS AUV*", Monterey, CA Naval Postgraduate School, Sept., 2003

3. Kucik, D., "*Follow-the-Leader Tracking by AUVs using Acoustical Communications and Ranging*", Monterey, CA Naval Postgraduate School, Sept. 2003